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Action Plan on seaweed exploitation, mariculture and utilization in India

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All macroscopic algae occurring in the marine, coastal and brackish water habitats are termed as seaweeds. They are valued commercially for their polysaccharides deposited in the cell wall besides, minerals, metabolites and nutraceuticals that can be developed from them. Along the Indian coast, 844 species of marine algae comprising 216 species of Chlorophyta, 191 species of Phaeophyta, 434 species of Rhodophyta and 3 species of Xanthophyta are estimated. The seaweed resources surveys carried out so far by the ICAR- CMFRI, Kochi; CSMCRI, Bhavnagar and NIO, Goa in the intertidal and shallow water areas of east and west coasts and Lakshadweep and Andamans, estimated a total standing crop of all the seaweeds in Indian waters as more than 2,60,876 tonnes (wet weight).

Acute shortage of agar yielding red seaweeds all over the world can jeopardize the research programmes in the fields of biology and medicine for want of agar and agarose. In India too reduction in the quantity of wild collected native seaweeds like species of *Gracilaria* and *Gelidiella* is being observed. Red seaweeds are now imported from Sri Lanka, Morocco and SAARC countries with import duty varying between 4–37%. Most of the agar producing units in India remain shut due to lack of raw material and high import duty. This acute shortage in raw material supply is mainly due to indiscriminate exploitation of seaweeds over the years from Tamil Nadu coast (3700-4500 tonnes dry wt/ year) coupled with habitat destruction.

In December 2003 the National Academy of Agricultural Sciences organised a Round Table on 'Seaweed Cultivation and Utilisation' to discuss various aspects of seaweed cultivation and utilisation in India pertaining to their resources and diversity, biomass estimation, sustainable exploitation, commercial cultivation and processing, herbaria and algal cryopreservation, introduction of exotics and problems faced by the industries. The recommendations that emerged out of the Round Table was brought out in the form of a policy document(*Seaweed Culture and Utilization*, No 22(2003) NAAS, New Delhi). During February 2016, the ICAR-Central Marine Fisheries Research Institute with the support of Department of Biotechnology, New Delhi organized a 'National Consultation on mariculture, utilization and value addition of seaweeds for the livelihood security of coastal population' and an Action Plan was prepared as detailed below.

A. Seaweed resources and exploitation

1. Undertake study to revise seaweed biomass estimates for commercially important seaweed resources since most records available are out dated (more than 30 years back).
2. A GIS map indicating the biomass for harvest along the Indian coast is very much essential.
3. Encourage proper scientific and improved seaweed collection methods for profitability and for sustainability, while avoiding over harvest, destruction of habitat and harvest of immature seaweeds.
4. Develop seaweed harvest calendar for each region.
5. Annual data on seaweed resources exploited, edible products and other products to be maintained and documented.

6. Identify reasons for decline and methods for repopulation.

7. Identify stress resistant strains from natural environment and also develop stress resistant strains of cultivable species.

8. The large scale exploitation of seaweeds for almost entire industrial units of our nation is from the south east coast and hence this exploitation and processing sector along the Gulf of Mannar and Palk Bay shall be certified by the Marine Stewardship Council or Aquaculture Stewardship Council.

B. Seaweed Farming

1. Identify ideal sites exclusive for seaweed farming for each State/ UTs towards socio-economic upliftment of the coastal community.

2. Improve seaweed farming methods- reduce recurring expenditure, develop off- shore farming methods.

3. Promote horizontal expansion of seaweed farming- Pilot studies to be conducted and development to be made only in areas where the coastal villagers are interested to take up farming.

4. Against the indiscriminate exploitation of seaweeds for commerce, seaweed mariculture is the only alternative towards steady supply of raw material and for sustainability, while the natural beds will be conserved. This has to be addressed through the Integrated Multitrophic Aquaculture (IMTA) programme along the Indian coast.

5. To ensure steady supply of raw materials, high priority to be accorded for large scale mariculture.

6. Explore import/ introduction of planting material both to reinvigorate and diversify the cultivars following all legal formalities.

7. In the context of Climate Change and its resultant sea level rise, estuaries are expected to be inundated with seawater and more and more protected bays and estuaries can be brought under seaweed cultivation. Brackishwater species of seaweeds if any can be considered for large scale cultivation.

8. Large scale cultivation of seaweeds for industrial requirements can be encouraged for mitigating ocean acidification and can offer livelihood support to many coastal fisherfolks. Creating awareness through socioeconomic interventions can bring in more benefits.

9. Carrying capacity has to be carried out in the seaweed farming sites to optimize the yield and to avoid crashing of crops as happened recently at Palk Bay in the case of *Kappaphycus alvarezii*.

10. Availability of seed stock is the major deciding factor for making commercial cultivation more viable. Hence the stock improvement and seed production technology can be attempted through biotechnological interventions in collaboration with the Department of Biotechnology, New Delhi. Natural seed banks can also be created either in ponds or in suitable sub-tidal regions.

11. Commercial farming of unconventional agarophytes such as *Gracilaria dura* and *G. debilis* (Gracilariaceae, Rhodophyta) and their value addition through linkage with industrial partners.

12. Introduction of new strains of *Kappaphycus* and other commercially important seaweeds such as *Gracilaria* NBr-10, a fast growing red seaweed from subtropical climatic zones.

C. Utilization

1. Utilization of seaweed and seaweed products, their value addition and postharvest technology are to be addressed with major thrust.

2. Programmes on utilization of spent biomass of seaweed industries for manure, biodiesel production etc should be strengthened.

3. Seaweeds are regarded as highly potential biomass sources for quality biofuel production due to their rapid multiplication and growth rate (8-10 times faster) compared to terrestrial and aquatic higher plants. Farming of marine algae is a green technology without the involvement of energy, fertilizers and chemical inputs and is not a labour intensive avocation.

4. Large scale mariculture of marine algae can definitely check ocean acidification considerably. It is estimated that 3% of world's coastal waters with seaweeds grown would produce 230 billion litres of ethanol.

5. As majority of seaweeds lack lignin and pectin on their cell walls, their breakdown and fermentation can be hastened and enhanced by the involvement of suitable microbes (*Bacillus* spp; *Vibrio splendidus* etc). The bioethanol thus produced from seaweeds can be blended with petrol. The energy content of algal biomass is roughly 4700 k cal/kg compared to the energy value of coal (3600-4200 k cal/kg).

6. For functional foods and bioactive secondary metabolites search for new seaweed species are to be strengthened.

D. Policy:

1. Seaweed based bio-stimulants for use in agriculture should be duly notified as agricultural inputs by the Ministry of Agriculture and Farmers' welfare.

2. Food Safety and Standards Authority of India (FSSAI) may be requested to harmonize Indian Standards for use of carrageenan as a food additive in line with the CODEX standards.

3. Adopt single window system in the form of a Nodal Cell for seaweed cultivation, processing and marketing to be set up under the Ministry of Agriculture and Farmers' welfare similar to the Bureau of Aquatic Products as in China, Philippines and Indonesia.

4. Explore the possibilities of lifting restriction on export of farmed red seaweeds. Anomaly in classification of agar, algin and carageenan under the Central Excise and Customs tariff requires to be rectified.

5. Clearance for use of specific coastal waters should be obtained for seaweed farming from Coastal Zone Management Authorities.

6. Cultivation of seaweeds and the harvested (wet/dry) seaweeds shall be treated respectively as agricultural cultivation and agricultural produces for the purpose of fiscal levies.

7. Seaweed cultivation should be encouraged and undertaken all over the Indian coasts as seaweed cultivation is ecologically safe and green technology helps sequester CO_2 levels and thus check ocean acidification.

8. For the production and marketing of value added products raw material exploitation from the natural beds should not be encouraged and the raw material requirement should be met from mariculture at least in a phased manner or limited the cast ashore materials.

9. Harvesting of seaweeds from natural beds to be regulated by fixing quota system and restricted during post reproductive stage (after completing the spore liberation) to ensure and enhance natural stock.

10. Harvesting seaweeds from the natural beds should be regulated in such a way that this process should not spoil the habitat.

E. Researchable areas

1. Integrated Multi Trophic Aquaculture (IMTA) – further refining for areas with high tidal amplitudes and horizontal expansion.

2. Integrated taxonomic approaches for documenting the seaweed resources of India.
3. Development of stress resistant and genetically improved high yielding strains of commercially important seaweeds for improving livelihood options of coastal communities.
4. Bio prospecting of novel molecules from marine algae of native origin for industrial and health applications.

For more livelihood opportunities, better utilization of seaweeds and to increase national production, linkages between researchers, farmers and industries must be strengthened through an All India Coordinated Research Project on Seaweeds.

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